



TENNESSEE DEPARTMENT OF

**EDUCATION**

FIRST TO THE TOP

## Principles of Engineering and Technology

<b>Primary Career Cluster:</b>	Science, Technology, Engineering, and Mathematics (STEM)
<b>Consultant:</b>	Casey Haugner Wrenn, (615) 532-4879, <a href="mailto:Casey.Haugner@tn.gov">Casey.Haugner@tn.gov</a>
<b>Course Code:</b>	5924
<b>Prerequisite(s):</b>	None
<b>Credit:</b>	1
<b>Grade Level:</b>	9
<b>Graduation Requirement:</b>	This course satisfies one of three credits required for an elective focus when taken in conjunction with other STEM courses.
<b>Programs of Study and Sequence:</b>	This is the first course in the <i>Engineering</i> and <i>Technology</i> programs of study.
<b>Aligned Student Organization(s):</b>	Skills USA: <a href="http://www.tnskillsusa.com">http://www.tnskillsusa.com</a> Brandon Hudson, (615) 532-2804, <a href="mailto:Brandon.Hudson@tn.gov">Brandon.Hudson@tn.gov</a> Technology Student Association (TSA): <a href="http://www.tntsa.org">http://www.tntsa.org</a> Amanda Hodges, (615) 532-6270, <a href="mailto:Amanda.Hodges@tn.gov">Amanda.Hodges@tn.gov</a>
<b>Coordinating Work-Based Learning:</b>	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit <a href="http://tn.gov/education/cte/work_based_learning.shtml">http://tn.gov/education/cte/work_based_learning.shtml</a> .
<b>Available Student Industry Certifications:</b>	Students may be qualified to sit for the American Design Drafting Association (ADDA) Certification Exam upon completion of the <i>Engineering Design</i> program of study.
<b>Dual Credit or Dual Enrollment Opportunities:</b>	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
<b>Teacher Endorsement(s):</b>	013, 014, 015, 016, 017, 018, 047, 070, 078, 081, 125, 126, 127, 128, 129, 157, 210, 211, 212, 213, 214, 230, 232, 233, 413, 414, 415, 416, 417, 418, 470, 477, 519, 531, 595, 596, 700, 740, 760
<b>Required Teacher Certifications/Training:</b>	Teachers who have never taught this course must attend training provided by the Department of Education.
<b>Teacher Resources:</b>	<a href="http://www.tn.gov/education/cte/ScienceTechnologyEngineeringMathematics.shtml">http://www.tn.gov/education/cte/ScienceTechnologyEngineeringMathematics.shtml</a>

## Course Description

*Principles of Engineering and Technology* is a foundational course in the STEM cluster for students interested in learning more about careers in engineering and technology. This course covers basic skills required for engineering and technology fields of study. Upon completion of this course, proficient students are able to identify and explain the steps in the engineering design process. They can evaluate an existing engineering design, use fundamental sketching and engineering drawing techniques, complete simple design projects using the engineering design process, and effectively communicate design solutions to others. Standards in this course are aligned with Tennessee State Standards for English Language Arts & Literacy in Technical Subjects and Tennessee State Standards in Mathematics.\*

## Program of Study Application

This is the first course in both the *Engineering* and the *Technology* programs of study. For more information on the benefits and requirements of implementing these programs in full, please visit the STEM website at <http://www.tn.gov/education/cte/ScienceTechnologyEngineeringMathematics.shtml>.

## Course Standards

### Safety

- 1) Accurately read and interpret safety rules, including but not limited to rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply. (TN Reading 3, 4, 6)
- 2) Identify and explain the intended use of safety equipment available in the classroom. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment. Incorporate safety procedures and complete safety test with 100 percent accuracy. (TN Reading 3, 4)

### Introduction to Engineering & Technology

- 3) Research the definition of each term within STEM: Science, Technology, Engineering, and Mathematics. Use these definitions and additional print and electronic resources (such as textbooks, National Science Teacher Association's STEM Classroom newsletters, or the websites of organizations like *STEM Connector*) to develop a written argument describing why science, mathematics, and technology are different than engineering, yet each influences engineering. Incorporate proper citation conventions used in STEM fields (MLA, APA, or other) to cite sources of information retrieved. (TN Reading 1, 5; TN Writing 2, 9)
- 4) In teams, produce a timeline or infographic illustrating important events in history, in a given time period, that specifically involve engineering. Use a variety of sources to gather data, cite each source, and briefly describe why the chosen source is reliable. (TN Reading 1, 8; TN Writing 2, 8)
- 5) As a team, develop a written explanation of how society benefits from the contributions of engineers in at least three different engineering disciplines. Provide detailed descriptions of each discipline and describe the specific benefits derived from each. For example, describe how

civil engineers improve the efficiency and safety of transportation networks through the construction of bridges, highways, and other public infrastructures. Documents should contain links to relevant websites to illustrate the ideas presented. (TN Reading 1, 2; TN Writing 2, 6, 7, 8)

### **Engineering Design Process**

- 6) There are different versions of the engineering design process. For example, examine the following framework endorsed by the International Technology and Engineering Educators Association (ITEEA):

- a. Identify the problem
- b. Identify criteria and specify constraints
- c. Brainstorm possible solutions
- d. Research and generate ideas
- e. Explore alternative solutions
- f. Select an approach
- g. Write a design proposal
- h. Develop a model or prototype
- i. Test and evaluate
- j. Refine and improve
- k. Create or make a product
- l. Communicate results

Citing this framework or other variations as approved by the instructor, compare and contrast what is involved at each step of the engineering design process. Explain why it is an iterative process and always involves refinement. (TN Reading 3, 4, 5; TN Writing 2, 4, 9)

- 7) In teams, evaluate an existing large-scale engineering design using the engineering design process. Produce a report on the chosen design, and assume the role of the engineering design team that produced the design. Document constraints that may have been faced by the design team, criteria for measuring the effectiveness of the design, and progress through each step of the engineering design process. Create and deliver a presentation appropriate for a career and technical student organization (CTSO) event. (TN Reading 3, 4, 5, 7; TN Writing 2, 4, 9)
- 8) Complete a simple design activity and apply the engineering design process to produce a model that an engineer would test. Define criteria for determining an effective design, describe constraints on the design, and document each step in an engineering notebook. At the completion of the design process, present the model to the class and critique the design of other classmates. (TN Reading 3, 4, 5, 7, 9; TN Writing 4, 7)

### **Fundamental Sketching and Engineering Drawing**

- 9) Define the differences in technique among freehand sketching, manual drafting, and computer-aided drafting (CAD), and describe the skills required for each. Create a two-dimensional orthographic (multiview) drawing incorporating labels, notes, and dimensions, using sketching/geometric construction techniques. Apply basic dimensioning rules and properly use different types of lines (e.g., object, hidden, center). The orthographic projections should include principle views of a simple object from top, front, and right sides. (TN Reading 3, 4, 5, 7; TN Writing 4; TN Math G-MG)

- 10) Building on the knowledge of a two-dimensional drawing, create simple isometric (3-D pictorial) drawings, properly using lines (e.g., object, hidden, center), labels, and dimensioning techniques. (TN Reading 3, 4, 5, 7; TN Writing 4; TN Math G-MG)
- 11) Use CAD software to create simple two-dimensional and three-dimensional drawings, accurately incorporating labels, notes, dimensioning, and line types to design drawings. Perform basic operations such as creating, saving files, opening files, storing files, and printing. (TN Reading 3, 4, 5, 7; TN Writing 4; TN Math G-MG)

### **Introduction to Measurement**

- 12) Use physical measurement devices typically employed in engineering to collect and build a dataset. For example, calipers may be used to measure the width of pens in the classroom, generating a dataset. Tools should include, but are not limited to, fractional rule, metric rule, dial caliper, and micrometer. (TN Reading 1, 3, 7; TN Writing 4; TN Math N-Q)

### **Class Project**

- 13) As a class, identify a problem in the school or community that can be solved by an engineer. Follow the design process to solve the problem. The class will collaboratively develop a paper following the format of a typical technical report (see components of the report below). Upon completion of the report, create and deliver a presentation for a CTSO event using appropriate citation conventions learned in the course. Refine the report as would a team of engineers by incorporating feedback from the presentation.

The technical report should include, but is not limited to:

- a) Background
  - b) Problem definition
  - c) Design constraints
  - d) Methodology
  - e) Data analysis (e.g., charts, graphs, calculations)
  - f) Results/Problem solution (including engineering drawings)
  - g) Conclusions and recommendations for future research
- (TN Reading 1, 3, 4, 5, 7, 9; TN Writing 2, 5, 6, 7, 8, 9, 10)

### **Standards Alignment Notes**

\*References to other standards include:

- TN Reading: [State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
  - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standard 10 at the conclusion of the course.
- TN Writing: [State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).

- Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standards 1, 3 and 10 at the conclusion of the course.
- TN Math: [State Standards for Mathematics](#); Math Standards for High School: Number and Quantity, Algebra, Functions, Geometry, Statistics and Probability.
  - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project-based activities or collaborate on lesson planning. While not aligned to one specific conceptual category, students who are engaging in the activities outlined above should be able to demonstrate quantitative, algebraic, functional, geometric, and statistical reasoning as applied to specific technical concepts. In addition, students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- P21: Partnership for 21st Century Skills [Framework for 21st Century Learning](#)
  - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.